Return to sports after multiple trauma: which factors are responsible? Results from a 17-year follow-up

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Abstract: OBJECTIVE: We hypothesize that the majority of polytraumatised patients are unable to maintain their preinjury level of sporting activity, and that musculoskeletal injuries are a major contributing factor. We assessed the impact of such injuries on sporting prowess, with a focus on isolating, particularly debilitating musculoskeletal trauma. METHODS: We conducted a cohort study of 637 patients at a level 1 trauma centre, to assess the long-term outcome of severe trauma on return to sporting activities (RTS). Data collated on the multiply injured patient included preinjury physical activity, standardized outcome scores (SF-12, GOS, HASPOC), and clinical follow-up of at least 10 years duration. The return to preinjury sports participation was defined as a primary outcome parameter. Regression analyses were performed to identify specific injuries interfering with the RTS. STUDY DESIGN: Prognostic study; Level of evidence, II. RESULTS: Mean follow-up was 17 ± 5 years. We included 465 patients, including 207 athletic and 258 nonathletic individuals. Mean age at the time of injury was 26 ± 11.5 years and injury severity was comparable between the 2 cohorts. The deleterious effects on quality of life and the total duration of the rehabilitation process were also similar in athletes and nonathletes. Athletes were more likely to be unable to return to preinjury activities, or to return to a lower level of sporting prowess posttrauma. We identified knee injuries as the type of musculoskeletal trauma most likely to be career ending for the athlete (odds ratio 3.4, 95% confidence interval, 1.4-8.3; P = 0.008). CONCLUSION: Our results demonstrate an enforced shift from high-impact and team sports to low-impact activities after multiple trauma. Injuries of the lower extremities, especially around the knee joint, seem to have the highest lifechanging potential, preventing individuals from returning to their previous sporting activities.

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Return to Sports After Multiple Trauma: Which Factors Are Responsible?—Results From a 17-Year Follow-up

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Objective: We hypothesize that the majority of polytraumatised patients are unable to maintain their preinjury level of sporting activity, and that musculoskeletal injuries are a major contributing factor. We assessed the impact of such injuries on sporting prowess, with a focus on isolating, particularly debilitating musculoskeletal trauma.

Methods: We conducted a cohort study of 637 patients at a level 1 trauma centre, to assess the long-term outcome of severe trauma on return to sporting activities (RTS). Data collated on the multiply injured patient included preinjury physical activity, standardized outcome scores (SF-12, GOS, HASPOC), and clinical follow-up of at least 10 years duration. The return to preinjury sports participation was defined as a primary outcome parameter. Regression analyses were performed to identify specific injuries interfering with the RTS.

Study Design: Prognostic study; Level of evidence, II.

Results: Mean follow-up was 17 ± 5 years. We included 465 patients, including 207 athletic and 258 nonathletic individuals. Mean age at the time of injury was 26 ± 11.5 years and injury severity was comparable between the 2 cohorts. The deleterious effects on quality of life and the total duration of the rehabilitation process were also similar in athletes and nonathletes. Athletes were more likely to be unable to return to preinjury activities, or to return to a lower level of sporting prowess posttrauma. We identified knee injuries as the type of musculoskeletal trauma most likely to be career ending for the athlete (odds ratio 3.4, 95% confidence interval, 1.4-8.3; $P = 0.008$).

Conclusion: Our results demonstrate an enforced shift from high-impact and team sports to low-impact activities after multiple trauma. Injuries of the lower extremities, especially around the knee joint, seem to have the highest lifechanging potential, preventing individuals from returning to their previous sporting activities.

Key Words: return to sports, multiple trauma, sports activity, rehabilitation, long-term outcome

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INTRODUCTION

Trauma is today considered a global disease and a major socioeconomic burden on society, especially because young and healthy individuals are commonly affected.[1] Fortunately, the majority of patients with single-system injuries are able to return to their premorbid level of function; often a key goal for most individuals. Therefore, it is of utmost importance to assess the impact of different injury patterns, their surgical management and rehabilitation protocols, and their ability to impact and impair return to sporting activities (RTS) or exercise.[2–5]

A number of studies have also investigated variables associated with poor outcome after multiple trauma. Predictors of a poor late clinical outcome in the existing literature include amputation, severe spinal injuries, multiple articular injuries, and lower extremity injuries.[6–9]

Although it has been suggested in some studies that the superior anatomic, physiologic, and psychologic capacity of athletes over the general population may play a role in improving overall outcome after severe trauma,[10,11] it remains unclear whether trauma victims benefit from high-level sporting participation, and whether or not this variable is a predictor of reduced mortality and morbidity. However, there is a scarcity of literature regarding patient-reported outcomes and RTS in multiply injured individuals. Furthermore, specific barriers, when resuming physical activities, remain unknown. The aim of this study is to answer the following questions:

1. how is the type and level of sporting activities affected by multiple injuries?
2. which injuries are responsible for persistent symptoms, physical impairment, and functional deficits, and thus

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which injuries prevent athletes to return to competitive or recreational sports activity?

MATERIAL AND METHODS

Study Design

The study was designed as a prospective cohort study. The investigation was performed at a Level 1 trauma center after approval by the local institutional review board and ethics committee. From all participating individuals, written informed consent was obtained. Surviving patients with multiple injuries admitted to a Level 1 trauma center between 1973 and 1990 were re-examined by an orthopedic surgeon after a minimum follow-up period of 10 years. The process of patient selection, recruitment, and bias avoidance has been previously published.[12]

To minimize the loss of follow-up (Figure 1), a meticulous re-invitation and contact strategy was applied. Survivors were recruited for follow-up by obtaining residences from the charts. If the residency had changed, current residences were gathered from registration offices. The patients were invited to a standardized physical exam by mail up to 3 times and by telephone. The self-administered patient questionnaire comprehensively covered physical activity characteristics. If patients abandoned a specific sports activity during follow-up, individuals were asked whether this was due to a particular injury of an anatomic region or other causes (eg, psychological reasons and loss of interest).

In all trauma victims, the *Tegner Activity Scale* (TAS) was used to characterize the level of activity.[13] The TAS is a patient-administered score first described in 1985, most notably used in publications to assess the mobility level of individuals participating in work and sports-related activities after knee injury. Patients without thorough documented TAS were excluded from the study (Figure 1). Individuals scoring a minimum of 5 points (eg, competitive cycling and recreational jogging at least twice a week on uneven ground) were classified as athletic, all remaining patients with primarily occasional or recreational physical activities were characterized as nonathletic.[14]

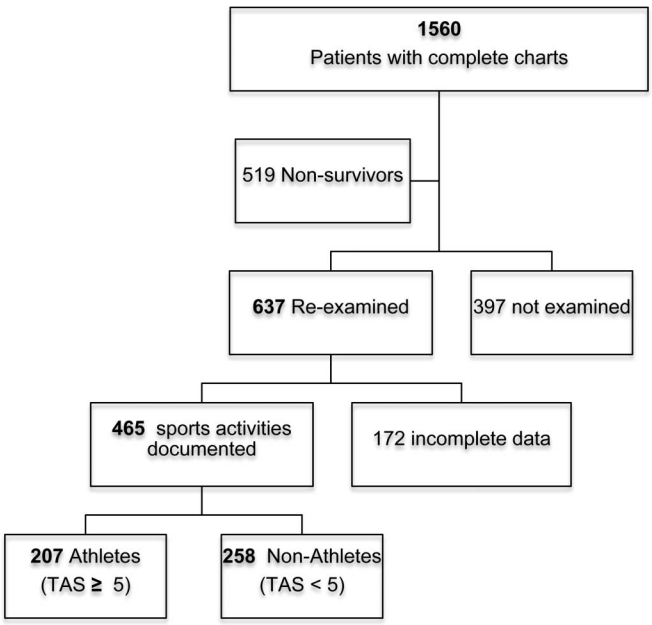

FIGURE 1. Recruitment of study cohort.

TABLE 1. Mechanism of Injury

	Number (n)	Percent (%)
Motor vehicle accident	250	53.6
(Motor-) cycle accident	126	27
Pedestrian vs MV	39	8.4
Fall from height (≥3 m)	14	3.0
Not further specified	4	0.9

Outcome Measures

Subjective Evaluation and RTS

The return to preinjury sports participation was defined as the primary outcome parameter. We assessed the number and the quality of activities (low-impact vs high-impact sports) of each individual. After obtaining informed consent, patients were asked to complete a self-reported questionnaire at the time of follow-up, which involved collecting data regarding the types of sports, level and frequency of activities before and after the injury occurred. Patients were asked to specify changes in the type, as well as level and frequency of activities over the course of the follow-up period, and to identify the anatomic site of injury representing the primary barrier for RTS and previous activities.

Objective Parameters and Score Systems

1. The duration and patient-reported success rate of all inpatient and outpatient rehabilitative therapies were documented.
2. The need for medical aids was evaluated.
3. The *Hannover Score for Polytrauma Outcome* (HASPOC) was applied to characterize the patient status after rehabilitation from severe to multiple injuries. A questionnaire and standardized physical examination was completed for the calculation of the HASPOC score.[15]
4. SF-12: The health-related quality of life was evaluated by the *SF-12 Physical Health Survey*.[16]

TABLE 2. Demographic Data at Follow-up

	TAS ≥5 (n = 207)	TAS <5 (n = 258)	*P*
Number, n (%)	207 (44.5)	258 (55.5)	—
Male, n (%)	171 (85.0)	176 (66.3)	0.001
Age at injury, yrs	25 (±10)	27 (±13)	0.031
Follow-up, yrs	17 (±4.7)	17.5 (±4.7)	0.456
ISS (points)	22.8 (±9.9)	20.4 (±9.8)	0.843
Alcohol abuse,* n (%)	11 (5.3)	14 (5.4)	0.915
Smoking,* n (%)	119 (57.5)	129 (50)	0.065
Married,* n (%)	56 (27)	92 (35.7)	0.048
Unemployed,* n (%)	11 (5.3)	14 (5.4)	0.915

*At time of follow-up.

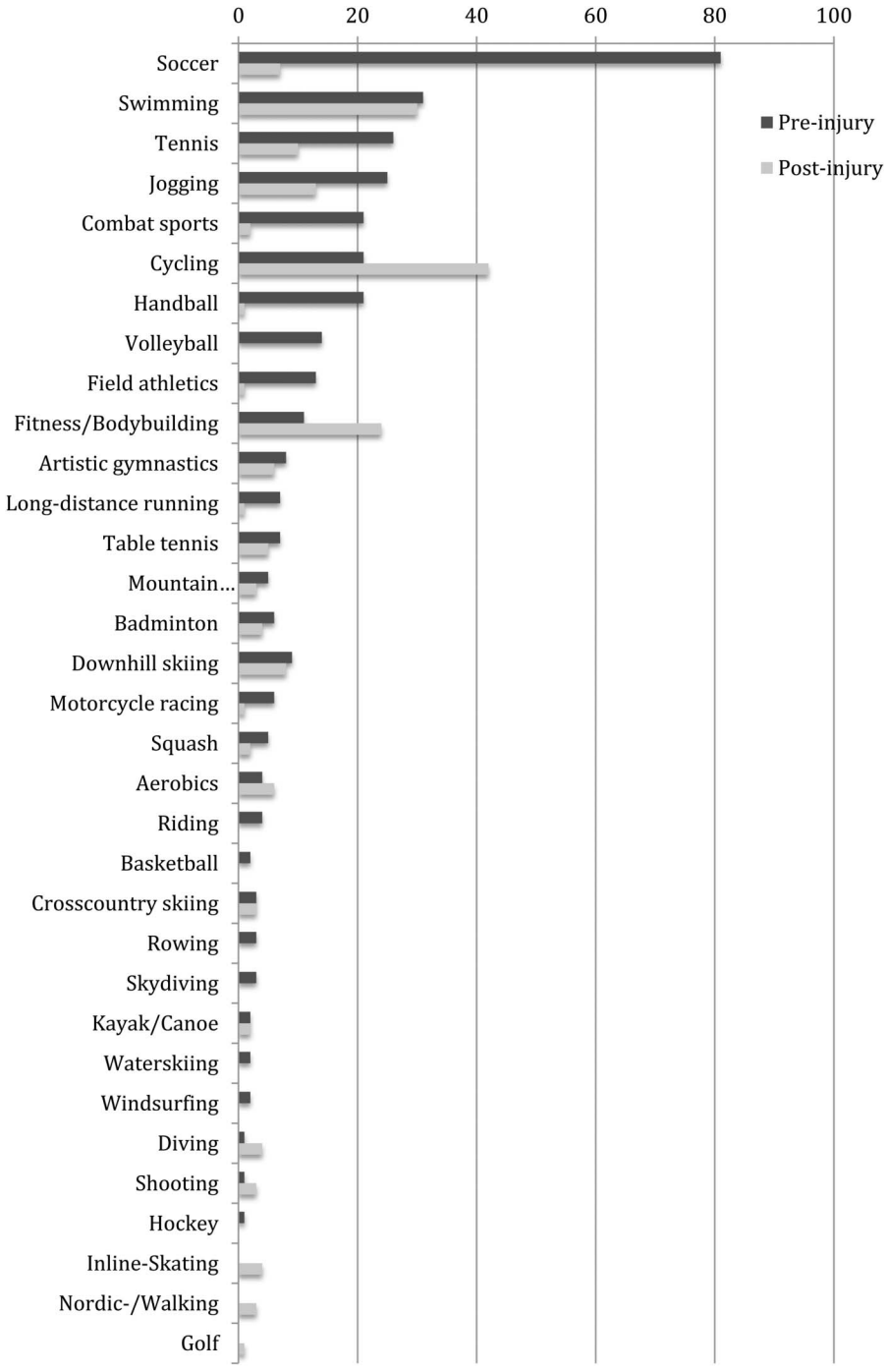

FIGURE 2. Type of sports activities, number of involved individuals before injury (black), and at time of follow-up (grey).

5. The *Glasgow Outcome Scale* (GOS) was compared for both groups.

Statistics

The IBM SPSS software for Windows was used to perform statistical analyses (Version 21; IBM Inc, Armonk, NY). All data were tested for normal distribution. Continuous data were described as means and standard deviation (SD), whereas categorical data were tabulated as frequencies. Results were considered statistically significant when a *P*-value of <0.05 was obtained. Descriptive statistics were performed for demographic data to determine statistical similarity between the cohorts. The Mann–Whitney *U* test was applied to test differences in scores between the 2 groups. Multivariate regression analyses were performed to calculate odds ratios (ORs) and 95% confidence intervals (CIs). This was to determine whether relationships existed between the anatomical site of injury and rate of RTS.

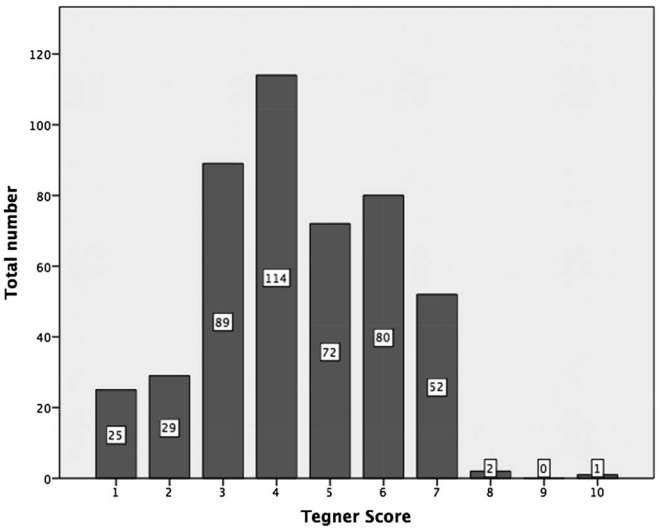

FIGURE 3. Preinjury tegner activity scale distribution.

RESULTS

A total of 465 trauma patients met the inclusion criteria and were included in the study (Figure 1). The mean age at the time of injury was 26 years (±11.5). The cohort consisted of 347 men (74.6%) and 118 women (25.4%). The mean Injury Severity Score (ISS, 21 ± 9.8 points) was comparable for both gender groups. The leading mechanism of injury (Table 1) was motor-vehicle accidents in 53.6%, followed by motor-/cycling accidents (27%). All patients were followed-up for a minimum of ten years. The mean posttraumatic follow-up was 17 (±5) years (Table 2).

According to the *Tegner Activity Scale* (TAS), 258 individuals (55.5%) with limited physical activity related to occasional or recreational sports were classified as TAS <5. A total of 207 individuals (44.5%) with ambitious sports activity on a regular basis, competitive or professional sports activities were classified as TAS ≥5. The mean preinjury TAS value for the athletic group was 6 points (±0.86) and 3 points (±0.97) for the nonathletic group. A more detailed characterization of the activity level of the study cohorts is provided in Figure 3.

The number of different sports activities per person declined in the follow-up examination in the athletic group from 1.87 (±1.01) to 0.98 (±0.91), reflecting a statistically significant decrease over the follow-up duration. A numerical loss of activities was more often found in athletes (59.1%) compared with the nonathletic reference group (26.5%). The distribution pattern among the type of sports activities also changed (Figure 2). More than half of the athletic population switched from high impacts sports (eg, soccer, combat sports, and handball) to less demanding activities (eg, swimming, cycling, and fitness).

The outcome scores regarding quality of life for both groups were comparable (Table 3). No differences were detected by the *Glasgow Outcome Scale*. The overall satisfaction with rehabilitation was 73.1% in athletes and 79.4% in nonathletes. A self-reported reduction in physical fitness was described by 74% of all athletes. Both groups required medical aids in similar frequencies (38.5%). There was a trend for a reduced time of inpatient and outpatient rehabilitation in athletes, but this finding was statistically not significant.

Injuries of the lower extremity (Table 4) were most often responsible for physical impairment. Patients identified injuries around the knee joint as primary cause of their posttraumatic impairment in sports (OR 3.4, 95% CI: 1.4-8.3; $P = 0.008$).

DISCUSSION

Previous studies suggest that a high number of physically active trauma victims consider the resumption in sports activities as the key functional long-term outcome parameter, and that biological variables (such as physical fitness) significantly affect survival rate and long-term functional outcome after trauma.

Our study investigated the effects of preinjury physical activity on posttraumatic rehabilitation and clinical outcome decades after trauma, and our study aimed to assess whether higher performing athletes felt an increasing gradient of morbidity and burden.

We feel that the long-term nature of this analysis in this paper is clinically important, because the majority of multiple injured individuals are not fully recovered after 12 or 24 months. To our knowledge, this is the first study investigating this relevant orthopedic sports medicine issue with a 10-year minimum follow-up period.

TABLE 3. Outcome Parameters

	TAS ≥5 (n = 207)	TAS <5 (n = 258)	*P*
SF-12 physical	43.9 (±11.1)	42.8 (±10.5)	0.153
HASPOC	66.7 (±45.0)	67 (±45.4)	0.400
Glasgow Outcome Scale (GOS)	4.88 (±0.406)	4.85 (±0.428)	0.151
Need for medical aids	38.5%, n = 80	38.5%, n = 99	1.00
No Return to number of sport activities	59.1%, n = 123	26.5%, n = 68	0.001
No Return to quality of activities (high vs low impact)	53.0%, n = 107	85.2%, n = 167	0.001
Reduced Fitness (self-reported)	74.0%, n = 154	68.1%, n = 175	0.183
Successfull Rehabilitation (self-reported)	73.1%, n = 152	79.4%, n = 204	0.124
Inpatient rehabilitation (duration in days)	79.2 (±164.8)	95.9 (±278.9)	0.264
Outpatient rehabilitation (duration in days)	266.7 (±692.7)	307.3 (±734.5)	0.450

TABLE 4. Regression analysis: Injuries interfering with return to sport

	P	OR	Lower 95% CI	Upper 95% CI
Head/facial	NS	1.96	0.72	5.33
Chest	NS	3.22	0.34	30.51
Abdomen	NS	0.71	0.02	22.89
Spine	NS	6.61	0.78	56.24
Upper extremity	NS	1.81	0.59	5.48
Lower extremity NFS	**0.018**	**2.54**	**1.17**	**5.51**
Lower extremity (neuro)	NS	0.50	0.88	2.87
Pelvic ring	NS	0.38	0.06	2.55
Hip/Acetabulum	NS	2.89	0.72	11.6
Femur shaft	NS	1.13	0.29	4.21
Knee joint	**0.007**	**3.4**	**1.39**	**8.27**
Foot/Ankle	NS	1.27	0.54	3.03

Boldface represents significant *p*-vaule.

CI, confidence interval; Neuro, neurological deficit; NFS, not further specified; OR, odds ratio.

Summarizing our data, a return to sports after severe trauma is not routinely achieved in the majority of cases. Athletes involved in contact sports (eg, soccer and handball) often gave up their contact sports activity (Figure 2). Injuries of the lower extremities and in particular around the knee joint were the most common barrier for a return to the previous level and type of sports activities. Most individuals were young and active before the injury, and thus the psychological and physical impact of major trauma is felt by these patients for many years. For this type of patient, the findings herein may be, especially helpful in guiding patient expectations.

The long-term outcome measured with objective score systems (SF-12, HASPOC, and GOS) were comparable between athletes and nonathletes. The number of sporting activities declined significantly in both groups.

Holbrook and colleagues initiated the Trauma Recovery Project to study variables associated with an inferior outcome after major trauma.[17]

Their results, published in the late 90s confirmed that extremity injury was negatively associated with 12-month quality of well being scores. Other injury-related variables (head, face, chest, and abdomen) were not significantly associated with outcome. Their study seems to corroborate our findings that injuries to the lower extremities seem to disable patients when returning to their previous sports activity and may therefore adversely affect the individual quality of life.

The analysis performed by Livingston et al[18] studied the long-term outcome of trauma patients admitted to the surgical intensive care unit. The group contacted 100 out of 241 trauma patients after a mean follow-up period of 3.3 years from discharge. The authors described the presence of significant impairments, including the inability to return to previous levels of activity and stated that survival should no longer be regarded as sufficient outcome to measure success. Ninety-four percent (94%) of those patients considered themselves as active without any restrictions before trauma. In the follow-up period, 66% reported to be less active. Even if many individuals felt fortunate just to have survived their injury, the authors described the outcome regarding the level of activity as suboptimal.

Miller et al[19] studied 35 trauma patients who survived prolonged lengths of stay in the intensive care unit and found that despite tremendous resource utilization, the majority of patients did not return to preinjury levels of functional daily living. Rutledge et al[20] described a relevant drawback when identifying variables associated with inferior outcome after trauma, that being that the ISS is unable to differentiate between poor care and severe injury.

Our data reflect that injuries around the knee joint have clinically relevant long-term implications, which is also supported by the findings of Kraus et al.[21] A series of 89 cases with tibial plateau fractures were followed-up for a minimum of 24 months. The authors described that the total number of sporting activities declined significantly from 4.9 at the time of injury to 3.6 at the time of the survey. However, they reported that 73% of their cohort was engaged in some form of sporting activity, reflecting that the study cohort sustained only a single injury pattern.

A relevant consideration when scrutinizing these data is that sports activities may be subject to temporary trends. For this reason, we believe that changes in the number of patients participating in "fringe" type sports, such as in-line skating or Nordic walking might not only be affected by their physical status alone. Another consideration is that the advancing age of the cohort over the minimum 10-year follow-up period may also affect the number and quality of activities. Despite the fact that the questionnaire specifically asked whether injuries were responsible for changes in the activity pattern, we acknowledge that patients might have underreported psychological factors or trivial co-factors such as a loss of interest.

Despite the above considerations, our study found that the significant differences in the posttraumatic quality of activities suggest that the physical status seems to be the most relevant determining factor.

Our results may help clinicians involved in sports medicine, orthopedic surgery, and rehabilitation therapy to set priorities in injury prevention and surgical care, and to guide postinjury physiotherapy, orthotic and prosthetic management, and psychological medicine.

Trauma patients might benefit from more detailed prognosis and recommendation of an individually adapted choice of future sporting activities. If a trauma victim is unable to participate in the preinjury sporting activity, physicians may recommend a conversion to lower impact sports (eg, swimming, cycling, and fitness) to preserve social integration, physical fitness, and to prevent from further physical inactivity.[22]

CONCLUSION

This long-term study was unable to detect an accelerated or more successful rehabilitation process in athletes, suggesting that despite higher levels of fitness and possible mental strength, the most important variable is the severity of the trauma and subsequent quality of care.

Our results also demonstrated a shift from high-impact and team sports to low-impact activities after multiple trauma.

Injuries to the most complex joint in the body, the knee, seem to have the highest life-changing potential, preventing individuals to return to their previous sporting activities.

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